AGRICULTURAL Research

JANUARY 1956

Bigger: tetraploid apples

● see page 3

Better: hybrid lambs

● see page 10

Tastier: new grasses

● see page 12

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURAL
Research

Vol 4—January 1956—No. 7

CONTENTS

Managing Editor: J. F. Silbaugh. Assistant Editor: J. R. Deatherage. Contributors to this issue: P K. Schultz, G. F. Snell, G. S. Kamran, C. L. Gaddis, E. Evers.

Changing patterns

We've noted with satisfaction the country's record in cooperative regulatory work. Progress against the hog disease vesicular exanthema is encouraging. Then there's the fight against Khapra beetle in the Southwest—another one we hope to win. Detection and eradication of the Mediterranean fruit fly from Florida in 1929, and the completed 40-year campaign in the South against the cattle fever tick are chapters we like to recall.

This work is often characterized by long, slow drives against such stubborn foes as tuberculosis—where we're over the top—and brucellosis—where there's progress but far to go.

The place of greatest drama naturally gets our attention—the place where danger exists and the outcome is uncertain. Plodding work of our border guards rarely is in the news. Yet, some of our more anxious moments and biggest domestic eradication problems were the result of a breaching of our international boundary by foreign pests and diseases. The stowaway that escapes detection is an ever-present threat.

On the whole, our inspection at the international boundary has been adequate for the times. But times are changing, and there are disquieting signs of this.

Consider modes of travel. This is the air age. International travel and freightage are at a peak. A lot of this is by air. Even our livestock—76 percent of the poultry, 54 percent of the horses, and 1 out of 9 sheep, goats, hogs, and zoo animals—comes in by air. Ship dockings have doubled and international airflights have increased 17-fold since prewar. One-third of those flights harbor plant material that must be barred.

Livestock's travel may be quicker than the incubation of its diseases—too quick for symptoms of diseases to show up.

International airports miles inland from the coast are a new inner border. We must redeploy and man that line, too.

The changing pattern calls for mobility in act and mind. Our defense team is alert to this situation. We must see that they have adequate counter weapons, suited to the times.

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BIG APPLE WITH A BIG FUTURE

This research-developed sport gives scientists valuable material for breeding better fruit

A BIG-APPLE Winesap sport recently produced may enable scientists to develop some varieties of the quality and size we've wanted.

The new sport from USDA research is tetraploid, with 4 sets of 17 chromosomes (68 in all) in each cell. Crossed with diploids—varieties with 2 sets—it would produce triploids, with 3 sets. About one-fourth of our good varieties are triploids selected for special characteristics from among the very few triploids provided by nature's random genetic procedures.

Doubling chromosomes usually means bigger fruits, too big in some cases. On the other hand, the diploid Winesap—basically one of our best apples—usually gives small-apple progeny when crossed with other small-fruited sorts. Breeders should now be able to produce triploid fruits of good market size. We can expect great benefit from this new plasm.

Nature sometimes doubles chromosome number in plants—has done so in a few apples. ARS has studied a few partial tetraploids that originated spontaneously in orchards—notably a Winesap sport found in the J. J. Reimer orchard at Palisade, Wash., and a McIntosh sport in the Roger Kimball orchard at Littleton, Mass.

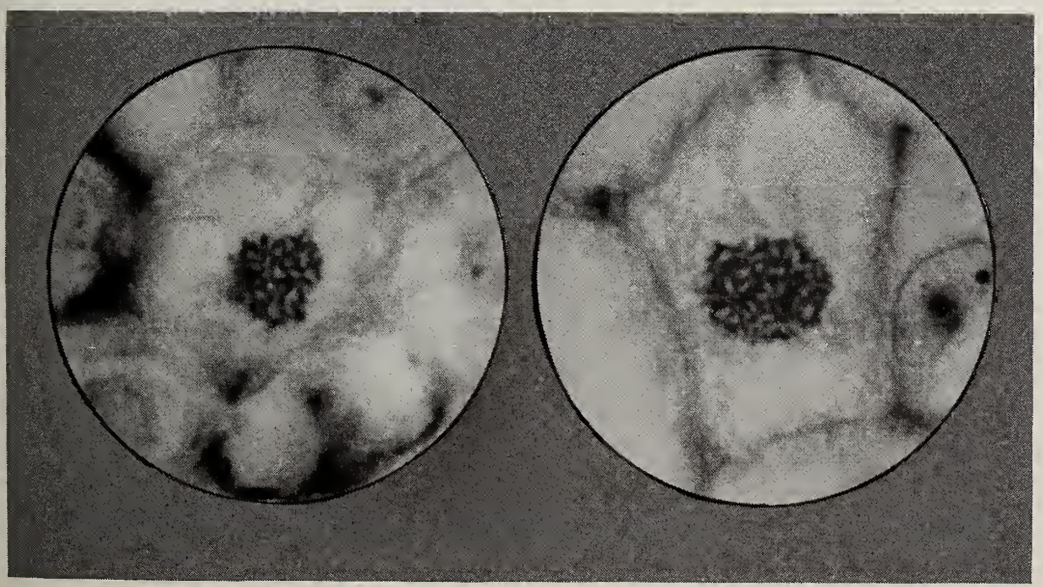
In apples, natural tetraploidy has occurred only in certain zones or tissues of the branch, bud, leaf, flower, and fruit—not completely.

When found, the Reimer Winesap sport was tetraploid only in the deepest tissues—ones not involved in reproduction. With diploid tissues in its outer cell layers, new growth might at any time originate solely from those layers and thus revert to the diploid state, losing the sporting character. However, the most important point is that the Reimer sport could not be used for breeding as it was.

The remodeled Winesap sport has big-fruit character in its reproductive tissue—in fact, in all its cells—and can transmit large-fruiting to progeny. Moreover, it can be budded or grafted without reversion. (Another limb sport of Winesap recently found in the Birchmont orchard near Wenatchee, Wash., appears to be tetraploid except in epidermis.)

This experiment is the latest of five instances—with McIntosh, Delicious, Ontario, Wrixparent, and now Winesap—in which tetraploidy occurred

GREATLY MAGNIFIED CELLS from the central portion (pith) of two apple shoots are from a diploid tissue (left) and tetraploid tissue (right) with 34 and 68 chromosomes, respectively. They're in the so-called Zone III of the plant. Greater size of the one cell is a typical effect of polyploidy, but chromosome doubling is the evidence that plant character has undergone change.



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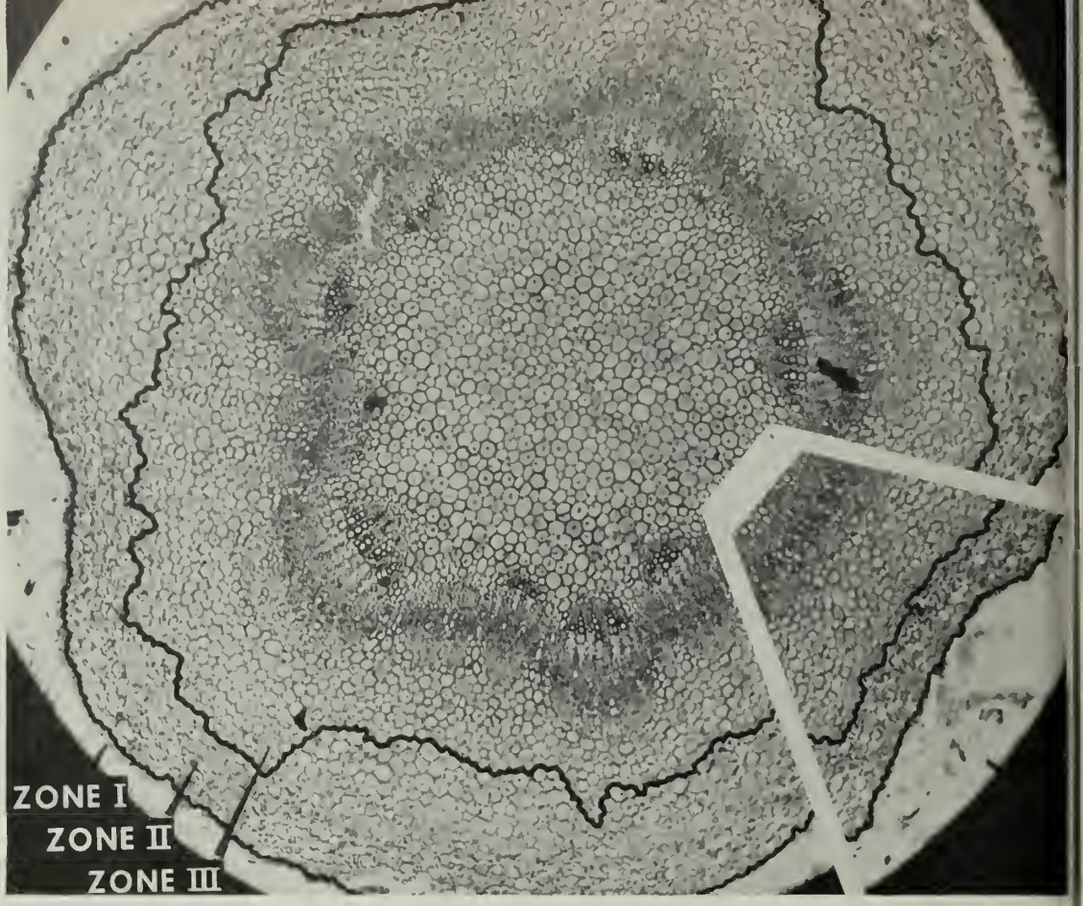
CALLUSES HEALED Winesap where vegetative buds had been cut out. In time, the lower callus (left) formed a shoot (right) that proved to have tetraploid tissue throughout.



STEM CROSS SECTION of an apple shows that a cutout (lower right) for removing a bud might force scar tissue from Zone III cells. That's the tetraploid zone in the Reimer Winesap sport that Dermen experimented with. When a shoot emerged from that deep scar tissue, it was naturally composed wholly of tetraploid cells. It was the "lucky accident" Dermen needed.

naturally in limited parts of the plant and was extended throughout the plant through the efforts of scientists. This was done by a highly imaginative plan of ARS cytologist Haig Dermen at the Plant Industry Station, Beltsville, Md.

Dermen knew of nature's principles for normal growth on aboveground parts of a tree—the forming of new buds and wood in a leaf axil at the node of a branch or young trunk. But he also recalled the adventitious buds and shoots that develop from roots of blackberries and other species and the small bud-like swellings occasionally noticed between the nodes on some apples. It occurred to him that there might be a method for encouraging adventitious bud development in abnormal situations.

Dermen tested his theory, first on some ordinary young apple trees, then on eight partially tetraploid sports available to him. All of them had normal diploid epidermal cells (Zone I). Zone II (the outer half of the bark just beneath the epidermis) and Zone III (the remaining inner portion of the stem) were tetraploid in three sports. A fourth sport, the McIntosh, was diploid-tetraploid-diploid in the respective zones. Four were tetraploid only in Zone III, which is the innermost tissues.

To block all tendencies toward normal growth, Dermen carved out all buds of 1-year-old or 2-year-old trees and cut off their tops. The plants callused over the cuts and, in the case of McIntosh and some others, forced an occasional adventitious bud between nodes. One McIntosh formed four such buds. The top bud put out three shoots, all diploid. Two other buds on the same side didn't develop. The fourth, on another side of the plant, put out tetraploid growth. Why the difference between sides?

The stem was thicker on that one side, suggesting that the vascular tissue there was tetraploid. It was already known that adventitious buds originate in the phloem region—outer vascular system—of the stem.

Tetraploid adventitious shoots also were obtained with Delicious, Ontario, and Wrixparent, which already were tetraploid except for epidermis. Experiments failed with the partly tetraploid sports of Winesap, Northern Spy, Jonathan, and Rome Beauty, but Dermen tried again with a number of year-old Winesaps, hoping that at least one "lucky accident" would bring about the desired result.

As in previous experiments, Dermen went quite deep—well into Zone III—to remove the normal buds. Very large calluses formed over the wounds. A few internodal swellings also developed, but nothing emerged from them. After about 5 months,

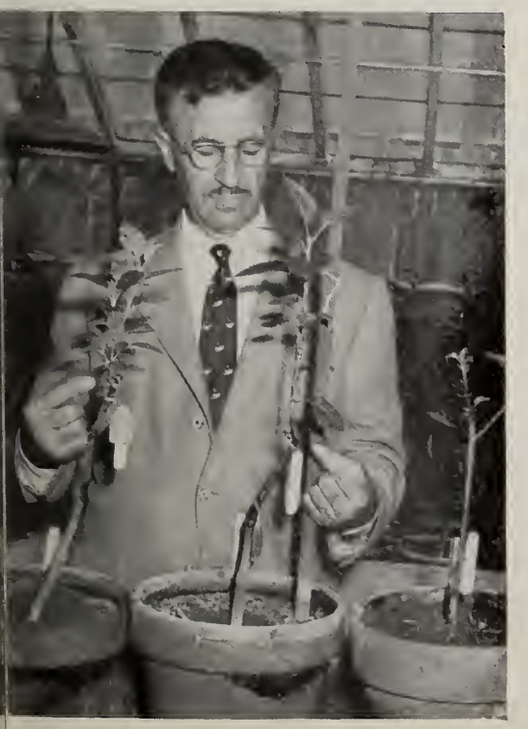
however, a shoot pushed out of the edge of one callus in one plant. The luck was on Dermen's side. That was our 100-percent tetraploid Winesap. Now other stock from that one shoot has been budded onto seedlings.

The Reimer Winesap sport has typical Winesap quality but is quite irregular in size and shape. We won't learn what the 100-percent tetraploid Winesap is like for perhaps 5 years. It may be too large for market. But there's a possibility that the asymmetrical pattern of the tetraploid zone in wood and fruit of the Reimer sport has something to do with its irregular shape—that a 100-percent tetraploid apple will be more uniform. We must wait and see it in fruit.

Uniform or not, this remarkable Winesap is going to be used as a parent with other tetraploids and likewise with diploidal varieties. Many varieties could benefit by incorporating Winesap quality and disease resistance into their basic makeup.

These are our hopes, but with tree fruits nature's pace is slow.☆

HOPES REST on the small tree at center with purely tetraploid branches and on the tiny bud graft by the label at lower right. A debudded Reimer sport (left) grew mere diploid top.



HALL SCALE: HOW LONG?

SPECTRAL FIGURES looming out of the California dusk (top) are coated-nylon gas chambers, on trees to kill Hall scale insects. Hydrocyanic gas is blown into tents, evacuated after treatment. Tents are carefully lowered and lifted by tent pullers (bottom) made with booms mounted on surplus Army weapon, personnel carriers.

■ BANISHMENT FROM THIS HEMISPHERE of a dangerous scale insect—so small that 2,000 of them can get on an almond hull without crowding—appears probable the next few years. The Hall scale, known throughout the Middle East, was first found at Chico, Calif., in 1934. It gained a toehold in two counties but has been found in no other State.

This prolific stone-fruit pest weakens infested trees and injures some fruits, conspicuously blotching peaches, nectarines, and plums. Because the insects hide deep in bark fissures of almond, peach, plum, nectarine, and prune trees, or spiraea bushes, hydrocyanic acid fumigation in gas-tight tents is the only known measure that gets them all.

California's department of agriculture and ARS have cooperated since 1941 in surveying for Hall-scale-infested trees, fumigating or destroying them, and restricting movement of host material. The aim: eradication.

Despite the exasperating difficulties of searching for such minute, well-hidden pests, substantial progress has been made toward ultimate eradication. More than 48,000 infested or suspect trees have been marked for fumigation or removal in the only infested counties, Butte and Yolo. Removal or fumigation of these trees is now about four-fifths completed. Of the three California areas where the Hall scale was found, the Davis and Oroville infestations appear to be eradicated and infestations have been progressively reduced in the Chico area.

An occasional infested tree is still found in a previously scale-free area. This makes control workers cautious about setting a deadline for eradication. Barring new findings, however, all plants requiring treatment will have been fumigated one or more times by the spring of 1957. Three fumigations are needed, and 3 years of surveys of formerly infested property must follow before eradication is reasonably assured.☆

THEY FORECAST BLIGHT

Warning based on weather records saved Maine potatoes

IN Maine's Aroostook County—where the potato is king—plant pathologists proved a theory last season and thereby helped growers protect their potatoes from late blight.

The theory: that this fungus disease can be predicted from weather records—predicted in time for growers to apply preventive fungicides.

Analysis of 52 years of weather records convinced pathologists R. A. Hyre, of ARS, and Reiner Bonde, of the Maine experiment station, that on-the-spot blight forecasting was feasible—that it would pay off in less disease and bigger yields.

The records show that late blight could have been accurately predicted in 48 of the 52 years. Furthermore, the disease could have been predicted 5 to 16 days before symptoms first appeared on potatoes. This much leeway, Hyre and Bonde figured, would give the grower ample time to spray his potatoes with fungicide.

So the county-size plan was put into operation as an extension of the ARS Cooperative Plant Disease Warning Service, which for 7 years has been providing many of the Nation's fruit, vegetable, and tobacco growers with advance information on several predictable diseases. Aroostook was selected because it's our biggest potato-producing county and because late blight takes an average of 5 percent—or about 3 million bushels—of the crop in this county each year.

Operating from Presque Isle, the scientists began June 1 to check over cull piles of potatoes as sources of the late-blight fungus. On June 26 they published their findings, which were relayed to growers by the county agent, extension specialists, newspapers, and radio. Their report said: 9 of 19 cull piles examined contained blight-infected sprouts—enough inoculum for an outbreak if weather became favorable for the disease. "Favorable" weather meant 10 consecutive days with a total of 1.2 or more inches of rainfall and a mean temperature of 77° F. or below.

Until August 12, weekly reports told of only a few cases of field infection and no late-blight threat. Then, after a cool, rainy period, and with more rain predicted, Hyre and Bonde warned that late blight would begin to develop and spread within a week or 10 days. They advised prompt and thorough fungicidal spraying.

Conditions continued favorable for disease spread. But because many growers heeded the warning and most of the fields had been sprayed, the scientists were able to make this final report on August 27: over the entire season, late blight was reported from only 19 commercial fields. In all but 2 of the fields, foliage infection was 1 percent or less, in those 2 fields, 25 percent. Usually, blighted areas were small and were kept under control by spraying. For the year as a whole, late blight on foliage rated very light in Aroostook County potatoes.

Hyre and Bonde don't credit all this success to their reporting system. On the basis of this year's results, however, they believe that timely reports, acted on by growers, would help keep losses at a minimum.☆

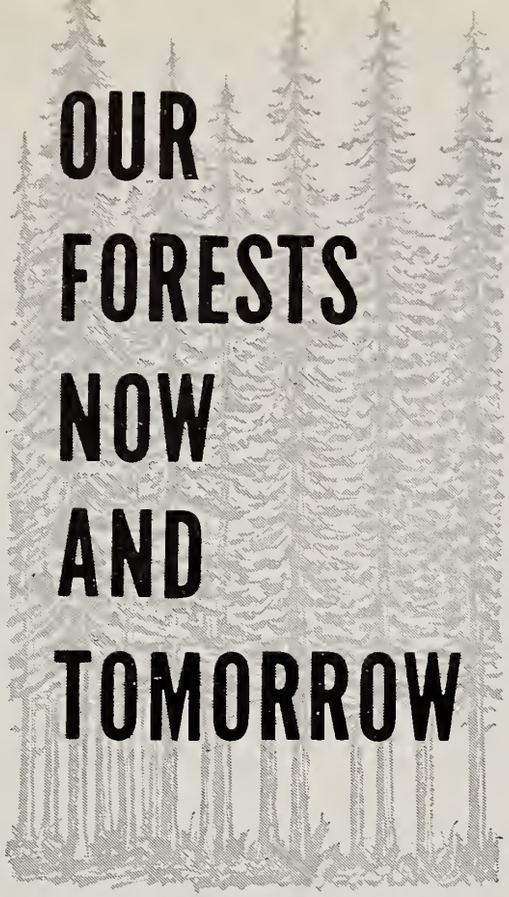
How to control late blight—as demonstrated in Aroostook County:

1. Locate sources of late blight and destroy them to prevent spreading. Here, pile of diseased, sprouting cull potatoes is buried.

2. Study the weather. Development and spread of late blight can be predicted from the rainfall and temperature records.

3. Spray potatoes with fungicides at the right time. Dosing foliage thoroughly will then protect the plants from late blight.

OUR FORESTS NOW AND TOMORROW



Timber Resource Review shows we have done well but must do much better to fill demand for wood

FORESTS all over the Nation got a thorough check during the recent Timber Resource Review. The findings indicate that improved forestry has increased our timber yields. But present rates of forestry progress still aren't high enough to supply the wood requirements for the number of people expected to be living in the United States in the years 1975 and 2000.

This look ahead leads USDA's Forest Service to estimate that timber production needs to be stepped up from 70 to 120 percent if it is to meet the needs of the future. More trees planted now, better stocking of cutover lands, and better protection from fire, insects, and diseases are necessary on both privately and publicly owned forest lands in this country.

The 3½-year survey of timber resources was made by the Forest Service with the collaboration of State forestry and other agencies, forest industries, and other public and private organizations. Cooperating agencies contributed over a half million dollars in manpower, equipment, and cash. The last survey, the Forest Reappraisal, was made in 1945.

The Timber Resource Review findings will be used by forest industries and by public foresters as a guide in long-range forest planning.

Some of the Review findings:

- The United States including coastal Alaska now has 489 million acres of forest land which we depend for our timber supplies. This land is all needed for timber production.
- Some 115 million acres—nearly one-fourth of all the country's forest land—are poorly stocked or nonstocked. About 50 million acres require planting if they are to become productive within a reasonable time.
- The study shows that over-all timber growth is increasing; on a national basis, sawtimber growth was nearly 9 percent more in 1952 than in 1944. Quality of timber in the forest, however, is declining to some extent.
- The condition of recently cutover lands was found generally to be best on lands owned by forest industries and on public forest lands; it was poorest on farm and other private forest lands. These farm and other private nonforest-industry owners of timberland hold the key to the Nation's timber supplies. On the average, their holdings are small—85 percent of them own less than 100 acres of timberland each. But in the aggregate, their 4½ million holdings comprise 60 percent of the country's total commercial forest lands and supply a substantial portion of the raw material for our forest industries.
- Greatest loss in potential timber growth comes from insects, diseases, and fire. Each year these kill an amount of sawtimber equal to one-fourth of the annual growth. Insects and diseases now outrank fire as killing agents. Much progress has been made in prevention and control of fire; a similar reduction in the toll of insects and diseases would contribute materially toward increasing our timber supplies in the future.
- One-fourth of the timber cut is now unused. Closer utilization and reduction of logging residues and unused plant residues would help to make available supplies go further.
- Greatest possibilities for adding permanently to the Nation's timber supplies lie in improving the stocking on the one-fourth of our commercial forest land that is now stocked poorly or not at all; in obtaining sufficiently prompt and adequate replanting on cutover acres so as to maintain their productivity; in realizing the growth potential—8 billion board feet a year—of the 50 million plantable acres; and in reducing losses due to insects, diseases, and fire.

Commenting on the findings, Forest Service Chief R. E. McArdle says: "We all know that there has been a lot of progress in forestry in recent years. But it isn't enough for present forest trends to continue; we must consider those trends in relation to population and other things in the national economy that will influence future demands for timber.

"Forestry is not a short-time proposition. Where this Nation stands in timber supply at the end of the century depends largely on actions taken during the next two decades. Whether there is time enough to gear up to levels of future demand by the end of the century, and still meet increasing needs in the meantime, must be regarded as a debatable question.

"If we accept the assumption that the population of the United States is going to keep on increasing at a rapid rate, and if we accept the best estimates of potential timber demand at all seriously, it is going to require an intensification of forestry effort ranging above and beyond what most of us have previously visualized."☆

TAMING THE WILD YAM

This source of cortisone might become a crop

TROPICAL yams of the *Dioscorea* family yielding as much as 10 percent diosgenin, a substance from which the antiarthritic hormone cortisone and related products are made, have been found by USDA plant explorers.

If these wild yams can be established as a commercial crop, they may well provide the dependable domestic plant source of cortisone raw material for which scientists have been searching. It was in 1948 that cortisone derived from animal sources—chiefly ox-bile, from which the drug is still made in this country—was found effective for treating rheumatoid arthritis. Ever since, demand for the hormone has made it urgent to find additional sources. In 1950 Congress authorized a cooperative project between ARS and National Institutes of Health.

Plant explorers have combed North, Central and South America, India, and parts of Africa looking for plants known to contain steroidal sapogenins—chemical compounds from which hormones such as progesterone and cortisone may be made. More than 5,000 samples were brought together for chemical screening. From these were selected the species showing the highest cortisone-precursor yields in the four great plant genera *Agave*, *Dioscorea*, *Strophanthus*, and *Yucca*. Now only the highest diosgenin-yielding species of *Dioscorea*—those found in Mexico and Central America—are being collected to get the best stock for agronomic tests and breeding work.

Search also continues for additional specimens of a rare type of wild Mexican yam (*Dioscorea spiculiflora*) that was found to contain two new sapogenins, in addition to diosgenin. Named gentrogenin and correllogenin, for ARS explorers H. Gentry and D. S. Correl who discovered the rare yam, the new plant chemicals are potentially much

1. This plant explorer searches high in Chilean Andes for wild yams suitable for growing in temperate climates. Primitive areas all over world are systematically explored to find new plant materials.

2. Highest diosgenin-yielding specimens of wild yam, *D. floribunda* (top) and *D. spiculiflora* (bottom), came from Mexico. The new sapogenins, gentrogenin and correllogenin, occur in *D. spiculiflora*.

5. Researcher makes leaf cuttings for field planting from wild-yam vines at the Glenn Dale Plant Introduction Garden. He uses new wood, mature enough not to wilt, with axillary bud and stem section.

6. After 9 to 12 months in greenhouse, yams are harvested for field tests. Vines are cut back and dried to slow growth and harden tubers for shipping. In 3 years, 70,000 plants have gone for testing.

better as starting material for cortisone manufacture than any natural plant source so far known. This is because they possess two desirable chemical structures (particular combinations of oxygen, hydrogen, and carbon atoms) that ordinarily occur singly in nature.

The explorers send samples of the plants they find to the Eastern Regional Research Laboratory at Philadelphia and to the U. S. Plant Introduction Garden at Glenn Dale, Md. Chemists at the Eastern laboratory analyze the plant material not only for steroid sapogenins but also for flavonols and alkaloids important in medicine and for tannins. Improvements in assay methods and in the use of steroids as cortisone precursors were developed in this laboratory. The two newly discovered sapogenins—gentrogenin and correllogenin—were isolated and identified by chemists H. W. Walens, S. Serota, and M. E. Wall.

Findings thus far have shown that *Dioscorea* is the most abundant and readily available source of cortisone starting material; it is also the most practical of these plants to cultivate. The most promising species of the genus *Dioscorea* are now being field grown to determine their rate of growth and cultural requirements as well as their yield of diosgenin and other sapogenins.

The wild-yam plants are propagated at Glenn Dale, where cultural methods are studied and selected plants are increased for field studies in warmer areas. Tests are made at Plant Introduction Gardens at Savannah, Ga., and Coconut Grove, Fla.; the Federal experiment station at Mayaguez, P. R.; University of Louisiana, at Baton Rouge; and commercial nurseries at Brooks, Fla.

On the basis of field tests made thus far, botanist Correll believes the high-diosgenin-yielding yams can be successfully cultivated in some of our southern States and in Puerto Rico. He adds, however, that it is difficult to establish a completely new crop from wild plants, even with modern argricultural knoweldge and methods.

Cultural needs of the wild yam are somewhat similar to those of the edible yam (not related to the sweetpotato) widely grown in the tropics and to a limited degree in this country. One of the problems is to provide a support for the vines, since tests indicate that wild yams have a higher survival rate and greater tuber yield when the vines are off the ground. But labor and material for putting up bamboo poles or wire add considerably to the cost of producing the yams. Also, artificial support interfere with cultivation. Experiments to develop a suitable living support for the vines are continuing.

Once the wild yam has been established, our plant geneticists will work to stabilize and increase the sapogenin yields through an intensive breeding program.☆

3. Yams and other plants are dried before extracting and testing for sapogenin. Quality and quantity of individual sapogenins, such as diosgenin, are later determined by more detailed chemical processes.

4. This equipment converts sapogenins to hormones, used in studying chemical suitability for cortisone synthesis. ARS-improved conversion method raises hormone yield from 50 percent to as high as 80.

7. Yams make consistently good growth in field at Baton Rouge, La., when planted 1½ feet apart with 5 feet between rows, hilled up, supported on wire. Deep furrow between rows allows ample irrigation.

8. About 190 Glenn Dale plants, field-grown 2 years at Brooksville, Fla., netted 85 pounds of tubers (the necks had been removed for replanting and some parts of root may have been left in the ground).

HYBRID LAMBS LEAD

Crosses have lower mortality, yield more meat and wool

HYBRID lambs that far outclass the finest strains of purebreds in meat and wool production and reduced mortality hold promise for the Nation's sheep industry.

Developed at USDA's Agricultural Research Center, Beltsville, Md., two-way and three-way crosses of purebred Hampshires, Shropshires, Southdowns, and Merinos have outperformed parent stock in practically every factor important to producers.

They have demonstrated the feasibility of producing such hybrids on a commercial scale from high-quality purebred and grade flocks maintained by growers. Further, they have shown the importance of maintaining high-quality flocks as a means of transmitting outstanding meat and wool producing characteristics to the progeny, along with hybrid vigor.

The breeding work which has had three phases, began about 30 years ago. The first phase was the development by USDA animal husbandmen of high-quality purebred flocks of Hampshires, Shropshires, and Southdowns. This was accomplished by selective mating and line breeding within each breed. The flocks and individual animals used represented the best strains of these breeds available in this country and Great Britain.

The second phase began in 1947. Its objective was to determine the commercial feasibility of using cross breeding to increase young lambs' vitality and their rates of flesh and fleece production. In barely 7 years of testing of every possible two-breed cross, the lambs produced have shown pronounced superiority in reduced mortality and in greater meat and wool production over purebred lambs from the same basic stock.

Three-way crossing, the third phase, was begun in 1951. This phase marked the introduction of Merino blood into the crossbreds to emphasize production of high-quality wool.

Results of both of these newer phases have shown definite superiority of the hybrids over the purebreds.

TWO-WAY CROSSES 7-year average	PUREBRED EWES	PUREBRED RAMS	CROSSBRED EWES	THREE-WAY CROSSES 4-year average
LL-13.7 % PI-71.0 Shrop-Hamp	Hampshire	Shropshire	Southdown-Hampshire	LL-11 % PI-78. Shrop-S'down-Hamp
LL-19.9 % PI-70.6 S'down-Hamp	Hampshire	Southdown	Hampshire-Shropshire	LL-10.8 PI-69 S'down-Hamp-Shrop
LL-19.2 % PI-67 S'down-Shrop	Shropshire		Shropshire-Hampshire	LL-20.4 PI-66. S'down-Shrop-Hamp
LL-27.5 % PI-62.4 Hamp-Shrop	Shropshire	Hampshire	Southdown-Shropshire	LL-18.8 PI-78. Hamp-S'down-Shrop
		Merino	Hampshire-Shropshire	LL-19.3 PI-74. Merino-Hamp-Shrop
			Shropshire-Hampshire	LL-14.8 PI-78. Merino-Shrop-Hamp

LL - Lambs Lost
PI - Production Index

Over a 7-year period, two-way-cross lambs have shown mortality averaging about one-third less than in purebreds; a weight increase of about 5 pounds at weaning (140 days); an increase of 10 to 15 percent in wool weight of yearling ewes.

Even greater results have been shown by the three-way-cross lambs, although animal husbandman C. G. Potts feels that the 4 years of breeding and testing under this project are insufficient to give a true picture.

Improvement achieved is measured by a "production index" calculated for each ewe, crossbred and purebred. A production index indicates the ability of the individual ewe to produce weaned weight of lamb meat as well as heavy yearling fleeces.

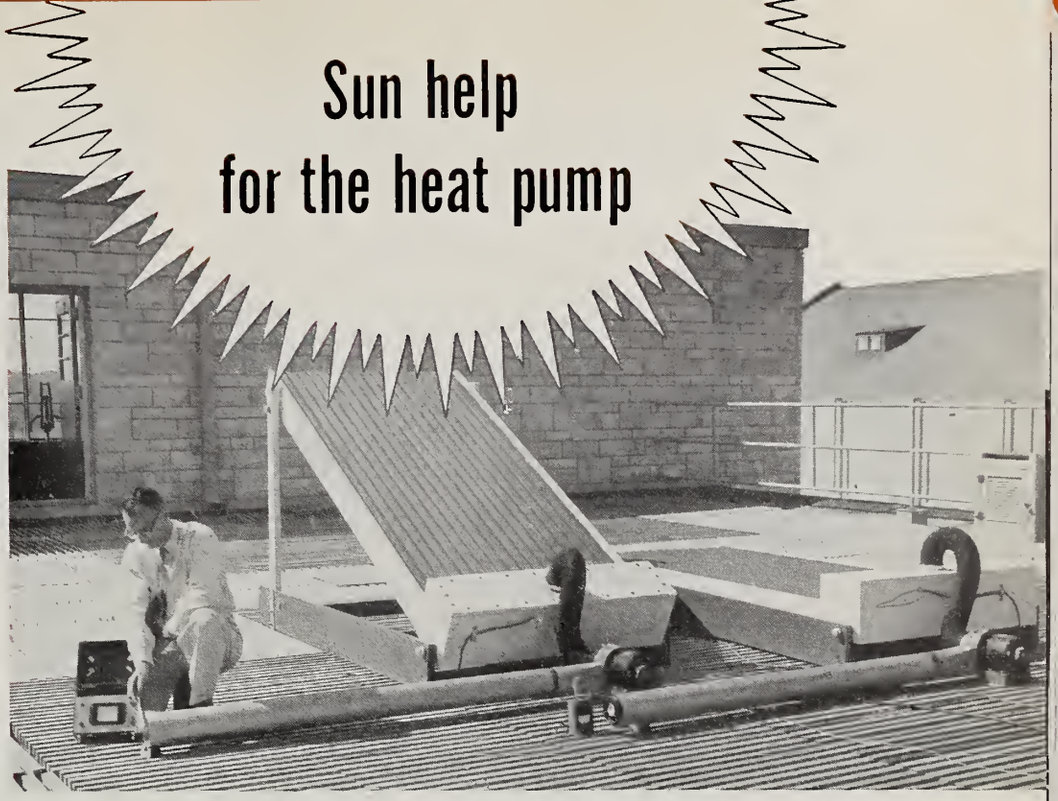
The 4-year average production index of 324 three-way-cross lambings (all such crosses in this experiment) was 74.4 with mortality averaging 15.8 percent. By comparison, 459 lambings of purebred ewes tested as a cross-check, had an average production index for 4 years of 62 points with mortality at 25.7 percent.

In the 7 years of experimentation with two-way-cross hybrid lambs, the ewes have an average production index of 67.8, with mortality at 20.1 percent. Purebred ewes for the same period had an average index of 58.1, a mortality rating of 29.3 percent.

Beltsville researchers are convinced that these striking results are no accident—that production of hybrid lambs on a commercial scale is both feasible and practical.

The experimental work is not complete, but its results are based on the use of purebred flocks in which, through years of improvement, inherent ability to produce meat and wool has become fixed. Thus, the scientists emphasize the importance of maintaining purebred flocks of highest quality and efficiency to be used successfully either in pure breeding or commercial crossbreeding.☆

Sun help for the heat pump



USING HEAT FROM THE SUN to supplement electricity in air-type heat-pump systems is a possibility with equipment recently developed. The new solar-energy collector, worked out cooperatively by scientists of USDA and the Kansas Agricultural and Engineering Experiment Stations, is expected to make heat-pump heating for houses more economical.

This device catches solar rays and transmits them to the air underneath, sometimes raising its temperature by as much as 13° F. A fan draws the warmed air over the heat-pump evaporator. The heat is picked up and transmitted to the air circulating in the building.

The collector consists of a sheet of galvanized corrugated metal roofing, painted black to increase its heat-absorbing capacity and used as part of a roof or wall section. (Pictured above are two collectors—one canted or tilted, and one flat against the roof. The engineers find that tilting the sections changes the rate of solar-energy absorption. In this experimental equipment, the air in the bed immediately beneath the corrugated metal is drawn off in the black hose. ARS engineer C. P. Davis is measuring the temperature of the heated air.)

A 600-square-foot collector—the size of a roof or south wall area on an average home—may provide enought heat on a typical Kansas winter day to cut electrical energy needs of a heat-pump-type heating system by about one-fourth during daylight hours. Moreover, if the collector is covered with glass, it will trap as much as 50 percent more usable energy. Glass allows the sun's rays to penetrate to the metal but prevents escape of the longer-wave-length infrared heat rays.

Davis, in charge of this experimental work at Manhattan, Kans., is trying to adapt the heat-pump principle of heating and cooling to a variety of farm uses. These include milk cooling, dairy water heating, hot and poultry house air conditioning, vegetable storage conditioning, and grain drying. He found that a heat pump attached to a commercial 50-gallon water heater supplies hot water for about half the electric energy used by a standard electric heater—and cools and dehumidifies the basement at the same time (AGR. RES., November 1953, p. 14).☆

Making New Grasses

SCIENTISTS TRY CHROMOSOME DOUBLING, CROSSING, IRRADIATION IN EFFORT TO DEVELOP HYBRIDS WITH GOOD QUALITIES OF FESCUES—PLUS PALATABILITY

TRIPLOID HYBRID GRASS (center) was produced in ARS research by fertilizing diploid perennial ryegrass (right) with pollen from a tetraploid meadow fescue (left). This hybrid, vegetatively superior to both parents, is largely sterile but was crossed successfully with other grasses. It is promising as a source of plasm to improve the quality of tall fescue.

THREE important genetic techniques have been used—2 somewhat successfully, and 1 hopefully—in USDA experiments to create new grasses with the assets but without the weaknesses of the various fescue grasses.

The prospect is fescues better fitting our various pasture needs.

The techniques are: (1) doubling of plant-cell chromosome number with colchicine to aid in crossing; (2) interspecies and intergenus crossing to recombine plant characters and give hybrid vigor, and (3) irradiation to change the pairing of the chromosomes and perhaps overcome sterility.

Tall fescue is one of our better grasses—at least, one of the most productive—for the humid East. It grows from Maine to California—grows actively except in prolonged summer droughts and winter cold. Being deep-rooted, it comes back well after drought. It gives year-round grazing in parts of the Deep South.

Tall fescue has a serious fault—relative unpalatability. Scientists at USDA's Northeastern Regional Pasture Research Laboratory, State Col-

FESCUE-RYEGRASS HYBRID, the triploid plant shown in foreground, has been crossed with each of its parent grasses and with tall fescue to produce a number of hybrid offspring, four of which show in the background. Difference in vegetative character is due to difference in chromosome number (21, 28, and 35) and in genetic combination. Third plant from the left, a natural outcross between the triploid hybrid and tall fescue, will be studied with special interest to see whether it has both productivity and meadow fescue's palatability.

CULM FROM TRIPLOID hybrid (left) is rooted in water for a few days and transferred to a 0.25-percent solution of colchicine for a few hours in the hope of doubling chromosomes in the growing points of the roots. The plant is then potted and grown out for breeding.

ROOT TIP SPECIMENS from full-grown colchicined plant will be studied by microscope to find whether the plant is now triploid, its original state, or hexaploid, as hoped. From this work we have several hexaploids that may prove valuable directly or in breeding.

lege, Pa., are trying to introduce the palatability character from common meadow fescue, another species of the *Festuca* genus, and particularly from perennial ryegrass which belongs to a different genus. But difference in chromosome number hinders crossing them with tall fescue.

The basic number of chromosomes in these grasses is 7. The simplest species (diploids) have 2 sets. Tetraploids have 4 sets, hexaploids 6 sets.

A few years ago plant breeder W. M. Myers and associates at the laboratory treated seeds of two diploid grass species with the drug colchicine—the palatable perennial ryegrass (*Lolium perenne*) and the somewhat less palatable meadow fescue (*Festuca elatier*). This produced tetraploids with double the normal number of chromosomes of the species.

Then plant breeder A. A. Hanson used the second technique—crossed ordinary diploid meadow fescue with diploid ryegrass, and tetraploid meadow fescue with tetraploid ryegrass. The crosses produced no seeds at the diploid level—but 12 hybrid seeds at the tetraploid level. The hybrids proved to be triploids, however, not tetraploids as expected. Investigation showed that the ryegrass mother plant was merely diploid.

Unfortunately, the resulting triploids were highly sterile, but they did accomplish in a limited way the aim of the experiment to combine two species. Moreover, the hybrids had certain desirable characteristics such as vigor and disease resistance.

By separating and rooting tillers (stems) from the triploid hybrid plants at the laboratory, plant breeder H. L. Carnahan has propagated several hundred triploid plants for further experimentation. They're identical with the 12 originals. Carnahan interpollinated some of these 21-chromosome triploids with the 14-chromosome ryegrass parents, the 28-chromosome meadow-fescue parent, and the 42-chromosome tall fescue (*Festuca arrundinacea*). He got over 1,000 assorted hybrids with 14, 21, 28, and 35 chromosomes.

That's a further elaboration of Hanson's hybridization plan. Plants from those seeds are being studied for disease reaction, productivity, persistence, and fertility under field conditions. Most grasses must produce seeds prolifically if they're to be grown as a forage crop.

Carnahan has also colchicined some rooted stems of the original fescue-ryegrass triploids and made hexaploids with 42 chromosomes. It should be possible to cross these plants with tall fescue that also has 42 chromosomes. Such a cross would again bring three species together but in different ratios than before. The ryegrass and meadow-fescue sources would then contribute half the genes in a cross with the hexaploid tall fescue, rather than the 25 to 40 percent already obtained in crossing triploid with hexaploid. The hoped-for cross of hexaploid with hexaploid would also stand a chance of producing good seed-bearing hybrids.

The simple two-way hybrids with three sets of chromosomes are more vigorous than either parent and more rust resistant than the original fescue. They might be commercially useful if their sterility is overcome. So Carnahan has had these sterile clones irradiated in the hope of getting useful plant material. It will take another 3 or 4 years, however, to learn what value irradiation may have.

Intergenus and interspecies hybridization is one of the tools that may break through the production ceiling after we have exhausted more orthodox breeding methods. Of course, it will take further testing to see just how effective it is. If successful, it will naturally be tried more extensively on other pasture plants.☆

DYE DOES IT

A simple, inexpensive dyeing test is called in to solve a variety of cotton-mill mysteries

CHEMICAL detectives—a red and a green dye—developed at USDA's Southern Regional Research Laboratory have proved invaluable as troubleshooters in cotton mills.

Let's take a typical case history and watch these sleuths in action: A mill was in trouble. White specks—apparently neps (small knots of tangled fibers that form during processing)—appeared in the material. The fiber itself was thought to be the guilty party, but these specks persisted even when higher grades of cotton were used. At an impasse, mill officials put our detectives—the differential dyes—on the case.

Application of this test in the mill's various processing stages soon showed there were many other defects that only looked like neps. This clue led to further investigation, which revealed that the operating rate of cards (tools that line up fibers in a uniform web before spinning) had been greatly speeded up in an effort to achieve higher production. This resulted in excessive nep formation. The fiber was not to blame.

By use of the differential dyeing test, the accused was exonerated. And the mill saved money because it did not need more expensive cotton—only a more favorable processing rate.

The test involves simple dyeing and inexpensive equipment. Cotton samples are dyed together in a bath of a mixture of two direct cotton dyes of contrasting color and very different dyeing characteristics—Diphenyl Fast Red 5BL, Supra I and Chlorantine Fast Green BLL. Samples are squeezed, then after-treated with boiling water to partially strip and clarify the colors. Excess liquor is quickly removed and the cotton dried.

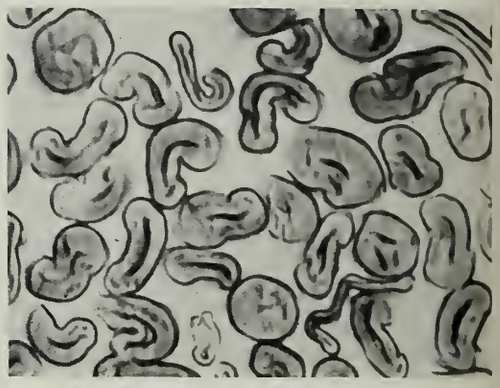
How does this test work? Immature, thin-walled cotton fibers pick up one color—green—from the dye bath. Mature, thick-walled fibers pick up the red pigments. This differentiation of fibers by color is mainly due to the great difference in fiber cell wall diffusion rates of the dyes used, and to the difference in dye absorption characteristics of mature and immature fibers (which depends on their cellulose structure).

The percentage of thin-walled fibers in mill lots of cotton is quite important. Too many of these fibers frequently cause difficulties in processing, increasing the cost of manufacture and producing inferior yarns and fabrics. Excessively thin-walled fibers lack both the strength and convolutions of thick-walled fibers, thus contributing less to the spinning quality of a cotton. They cause excessive neppiness in the yarns and react differently from mature fibers in dyeing processes. This leads to difficulties in precisely matching dye shades from one lot to another and in dyeing the lots uniformly.

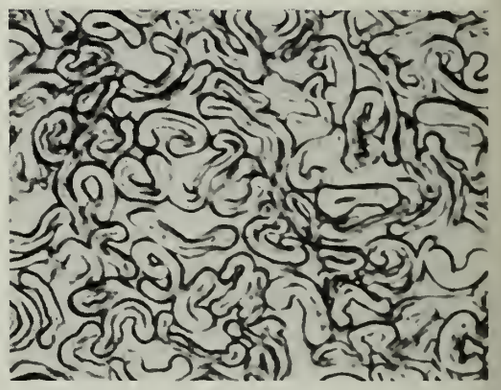
The differential dyeing technique has proved quite versatile. In addition to its use in maturity estimation, this test can distinguish cottons that would cause trouble in manufacturing and dyeing, diagnose the cause of imperfections in yarns woven into fabric, and predict the amount of nepping likely to occur. It can be used to study the effects of wet abrasion of both cotton and rayon fibers during finishing, to trace processing troubles, and to help select cotton with special properties for manufacturing special fabrics. In addition, the dye test is thought to be the only practical method for indicating a form of incomplete development of the cell wall at both base and tip. The technique has shown that the use of higher grades of cotton doesn't insure correspondingly better fiber development.

Cotton processors find the differential dyeing test valuable—simple to use, a saver of time and money. It is now employed by a number of large cotton processing mills. More adaptations of the test are anticipated.☆

COTTON goes into a mixture of green and red dyes in the easy differential-dye test.



MATURE, thick-walled fibers pick up red dye, spin well. (Cross section of fibers.)



IMMATURE, thin-walled fibers pick up the green, spin poorly. (Magnification: 500 x.)

Report on Antibiotics

HERE ARE SOME HIGHLIGHTS FROM THE INTERNATIONAL CONFERENCE

WORLD-WIDE interest in antibiotics led to the International Conference on the Use of Antibiotics in Agriculture, held at USDA in Washington. Sponsors were the National Academy of Sciences and National Research Council. Some 400 persons from the United States and 15 other countries attended.

The October conference was called to evaluate present information on growth and other responses of livestock to low-level antibiotic feeding, antibiotics in crop production and food preservation, the influence of agricultural uses of antibiotics on antibiotic-sensitive microflora, antibiotic effects on reproduction and carcass quality in livestock, antibiotic residues in human food, mode of action of antibiotics, and discussion of problems requiring research.

Unbelievably small amounts of antibiotics make pigs and chickens grow more and faster on less feed. This may become a major factor in agriculture everywhere, as it now is in the United States. As little as 10 grams (just over ⅓ ounce) per ton in the ration of hogs may increase growth 10 to 20 percent and save about 20 pounds of feed for every 100 pounds of animal gain, said T. J. Cunha, of the University of Florida.

Some researchers found that increased growth is often not present in young animals fed antibiotics and raised under the best conditions of nutrition and sanitation. But T. D. Luckey, of the University of Missouri, reported on some chickens and turkeys that showed growth response in a germ-free environment.

No effect of antibiotic feeding on reproduction has been demonstrated, but mortality in newborn animals is reduced in antibiotic-fed chickens, poults, pigs, calves, and lambs.

USDA research reported by N. R. Ellis showed that an extra pig or two per litter was weaned when the sow's diet was supplemented with an antibiotic during gestation and lactation. The extra pigs were due to better ability to survive to weaning.

Tests at USDA have indicated some beneficial carryover effects in chicks hatched from eggs of antibiotic-fed hens. Researchers now feel reasonably sure that antibiotics do no harm when fed to swine and poultry during the reproductive cycle.

There are probably four reasons for this growth-promoting effect, explained C. A. Baumann, University of Wisconsin biochemist. First, farm animals may be subject to many unknown diseases that are too mild to be recognized but nevertheless interfere with normal growth; the antibiotic checks the growth of the bacteria causing these diseases. Second, the antibiotics probably encourage the growth of other organisms that synthesize vitamins in the animal itself. Third, they may kill bacteria that normally compete with the animal for these vitamins. Fourth, they thin the intestinal walls, permitting better absorption of vitamins and other nutrients by the animal.

E. Freerkson, of Germany, supplied an additional hypothesis—that antibiotic feeding must result in supplying some directly essential substances, perhaps hormone precursors.

It was generally agreed that the mode of action of antibiotics must be determined in order to make further research fully effective.

The drugs also are important in treating costly livestock and poultry diseases, reported B. S. Pomeroy, of the University of Minnesota. Adding antibiotic to feed at the rate of 50 to 1,000 grams per ton, or to water at the rate of 25 to 250 parts per million, has proved quite effective.

Emergence of tolerant or resistant bacteria requires additional research. J. J. Christensen, of the University of Minnesota, reported on variation, including many mutations, occurring in fungi grown in media containing antibiotics. Apparently no mutants have yet been found in soil microflora as a result of antibiotics that were naturally produced there.

Antibiotics may affect heredity of lower organisms such as molds and thus be helpful in genetic study.

H. Clausen, of Denmark, gave evidence that low-level antibotic feeding had no adverse effect on carcass quality of swine under controlled feeding. He warned, however, that pigs allowed all the low-protein feed they would eat might become excessively fat since antibiotic feeding generally increases feed intake. Some U. S. researchers have reported that protein level may be decreased in the diet of antibiotic-fed pigs.

Ecology of antibotic-producing fungi was discussed by two Russian scientists. E. N. Mishustin reported effects of antibiotics inhibiting the action of nitrogen-fixing bacteria. N. A. Krasilnikov reported plant protection against disease by absorption of antibiotics produced by fungi naturally occurring in the soil.

Application of antibiotics to plants for control of many diseases was reported by W. J. Zaumeyer, of USDA. The big problem now is to find antibiotics that are effective in sufficiently low concentrations to be economical for commercial crop use.

Rigorous tests for safety will delay the use of antibiotics in food preservation until the public can be fully assured that there is no health hazard from antibiotic residues.☆

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agrisearch notes

CAREER EMPLOYEES have been appointed to two important ARS administrative posts.

E. C. Elting, 26-year veteran in USDA and State experiment station research, became ARS Deputy Administrator for Experiment Stations November 7.

This new position provides high-level coordination of Federal funds for State research. Such grant funds have been doubled in the last 2 years and total about $25 million annually.

In addition to representing the Administrator in all relations with the State experiment stations, Elting will also supervise two operating experiment station divisions in ARS.

C. H. Wadleigh, head of work on soil and plant relations, succeeded the late R. M. Salter as Chief, Soil and Water Conservation Research Branch.

DISCOVERY OF THE CHEMICAL makeup of a sesame-oil product that boosts the killing power of pyrethrum insecticides 30-fold may stimulate the South's infant sesame industry.

The new product is sesamolin, strictly a laboratory chemical as yet. Sesamolin not only boosts the kill—it increases the knockdown, too.

Several toxicity boosters (synergists) are used commercially to raise the effectiveness of some 50 million pounds of insecticides each year.

USDA chemist Morton Beroza obtained sesamolin from sesame oil and proved its toxicity-boosting power at the ARS Agricultural Research Center, Beltsville, Md. He has found that sesamolin has a methylenedioxyphenoxy molecular group, so is just slightly different from present commercial boosters, which contain a methylene dioxyphenyl group. That small difference has a big effect. It takes 5 times as much of the best commercial synergists for a 12-fold boost as the amount of sesamolin that will boost pyrethrum's effectiveness 30-fold.

Knowing the chemical structure of sesamolin may lead to development of more effective synthetic booster compounds for use in insecticides.

A pyrethrum insecticide is quite effective against flies, mosquitoes, and many other insects, but almost entirely non-toxic to warm-blooded creatures. Therefore, it's used in homes, restaurants, and dairies.

Sesame growing, just starting in the South, picked up when cooperating State-USDA researchers created new non-shattering varieties that could be harvested mechanically. Plantings were 12,000 to 15,000 acres in 1955. Demand for sesamolin may further stimulate production.

AN ORIENTAL LADY BEETLE that preys on many citrus and vegetable pests is being tried out for insect control in several Florida groves.

The beetle, technically called *Brumus suturalis*, appears to be strictly a friend of man as are most of its lady-beetle relatives in this country. It leaves our crops alone but feeds on insect pests such as aphids, white flies, psyllids, mites, and some scale insects and mealy bugs that are troublesome and costly on Florida citrus and vegetable crops. It has been released in 19 citrus groves.

ARS entomologist G. W. Angelet brought *Brumus* to this country from Pakistan. A. G. Selhime, working with it in Florida, thinks it'll thrive on insects there.

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